**RESEARCH REPORT**
**(for RTOPs and Grants)**

| **1. Title** | | **2. Date Prepared** |
|---|---|---|
| Multi-modal Image Registration and Mapping for Titan Aerobots | | 09 15 2008 |
| **3. Performing Organization:** | | **4. RTOP/Grant No.** |
| Jet Propulsion Laboratory | | |
| **4.A. JPL Project Number:** | **(Per GSK Policy, this serves as the Work Authorization Document)** | **4.C. NASA WBS NUMBER** |
| **102294-982745.03.12** | | **982745.02.02.03.12** |
| **5. Investigator** **Telephone** | **6. NASA Program Manager** | **7. NASA Division** |
| Larry Matthies 818-354-3722 | | |
| Adnan Ansar 818-393-7242 | **Joseph Bredekamp** | Science Mission Directorate |

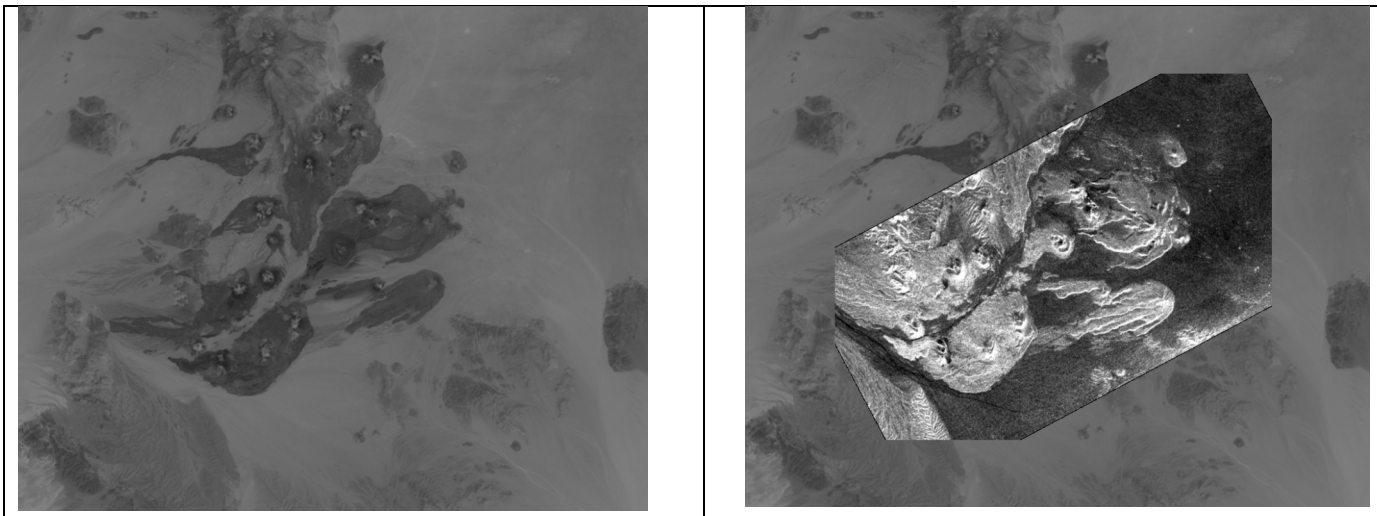
**8. Reference**
**NRA Number: NNH07ZDA001N-AISR Other:**

| **9. Funding Profile:** | **FY'08 Prior Approvals** | **FY'09 Current Guideline** | **FY'09 Current Request** | **FY'09 Current Overguide** | **FY'10 Next Request** |
|---|---|---|---|---|---|
| | $ 125 K | $ 0 K | $ 0 K | $ 0 K | $ 0 K |

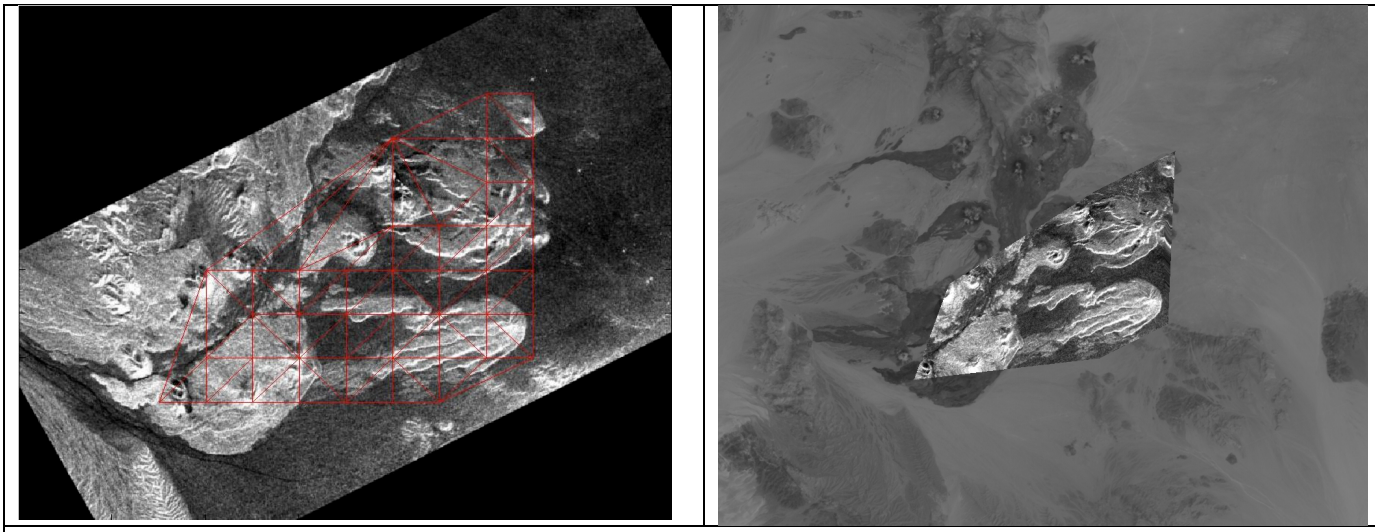
**10. Description**

**FY'08 Technical Accomplishments:**

1. Developed prototype multi-modal image registration algorithms derived from techniques in medical imaging community for automatic registration of imagery across sensing modalities including visible, thermal and RADAR.
2. Demonstrated match capability using Cassini-Huygens data: specifically showing match between Cassini SAR and Huygens DISR mosaic with accuracy equivalent to hand registration.
3. Demonstrated match capability between Cassini SAR and VIMS instruments with match accuracy equivalent to hand registration.
4. Obtained terrestrial datasets spanning multiple spectra from two sites (Rancho Cima and Death Valley). Modes included visible, thermal IR and C- and L-band SAR.
5. Demonstrated match capability on terrestrial datasets in item 4 across wide collection of varying spectra and relative image contrast conditions.
6. Obtained datasets of Mars from Phoenix descent site.
7. Demonstrated match accuracy for data in item 6 with results identical to hand registered ground truth.
8. Developed preliminary image warping technique to achieve exact, pixel-to-pixel registration between sensor data with different image formation geometries.
9. Performed preliminary experiments on match accuracy vs. image template size, including initial timing and computational complexity experiments.
10. Studied inherent orientation and scale insensitivity of match algorithm and derived preliminary requirements.



Automatic match showing overlay of C-band SAR (right inset) onto SWIR image (left). SAR data is from AirSAR (5.8 cm, TP polarization state) and SWIR data is from ASTER (1600-1700 nm band). While match is correct in a global sense, there are local misregistrations due to differences in viewpoint and fundamental imaging geometries.



Prototype registration refinement: Triangulation of salient feature network (left) for local, nonlinear image warping resulting in better local registration (right). Image landmarks now match in spite of fundamental differences in SAR and SWIR imagery.

**FY'08 Travel and Presentations:**

1. Presented project status and accomplishments at AISR PI meeting (May, 2008).
2. Preparing submission (due in November) to IEEE Conference on Computer Vision and Pattern Recognition 2009.

**FY'09 Plans:**

1. This task is a one year seed funded effort. However, due to staffing constraints and delays in funding start date for FY'08, we have asked for and received a no-cost extension to complete work and exhaust funding by the end of Q1, FY'09.
2. A detailed final report covering progress to date as well as work performed during the extension period will be submitted to the program manager by the end of the current calendar year.
3. Based on results to date, a new proposal was submitted to AISR to extend this work while simultaneously broadening its scope to encompass science relevant applications more directly.

| **Approval:** **Date:** | **Concurrence:** **Date:** |
| --- | --- |
| | |